**Earth’s Energy Budget Basics**

***STUDENT REPORT EXAMPLE***

Purpose:

This lab was completed in order to determine the albedo—the ratio of reflectivity—and the infrared radiation—the heat emission—of different colors and surfaces, as well as to determine the relationship between albedo and infrared radiation, which provides useful data in the selection of different colors and materials.

Background:

These measurements are also directly related to Earth’s energy “budget,” which refers to the amount of energy that comes into and leaves Earth. The Earth needs a balanced energy budget—that is, it needs to send as much energy out as it takes in—in order to maintain its climate. The albedo is the amount of sunlight that is reflected back into space, while infrared radiation can be either sent back out to space or kept at Earth (the greenhouse effect).

Method:

To perform this lab, the reflected light value of various colored papers, aluminum foil, and other surfaces in a chosen area of the NCSSM campus was measured using a Vernier light sensor, which was set at 0-600 lux range when measurements were taken inside and at 0-6000 lux range when measurements were taken outside.

The reflected light value for the aluminum foil was arbitrarily assigned a reflectivity of 1, and was thus used as the denominator in calculating albedo.

An infrared thermometer was used to measure the infrared radiation from the same surfaces, with an output in degrees Celsius.

Observations:

By comparing the albedo and infrared radiation of each surface, we were able to determine the relationship between these two characteristics.

*The surfaces with higher albedos tended to have lower infrared radiation*—such as the aluminum foil, which had a reported temperature of 0°C with an albedo of 1. This suggests that surfaces that reflect a great deal of light do not absorb as much heat (and thus do not emit as much heat).

*The surfaces with lower albedos had higher infrared radiation levels*—such as the black paper, which had a temperature of 25°C with an albedo of only 0.586. This suggests that surfaces that do not reflect a great deal of light absorb more heat (and thus emit more heat).

However, some of our data on the surfaces in our area did not follow this pattern; for example,

* The steam grate had a relatively high albedo AND temperature. However, this could be attributed to the fact that this surface had a source of heat besides the sun—the steam.
* Also, cloud cover and the fact that our light sensor was not set on the highest possible setting (and thus caused some surfaces to have light reflection values that topped out) could have caused errors in our data.
* Moreover, if we varied the distance that the light sensor was held from each of the surfaces, our values could have been erroneously affected.

Conclusions:

Based on the values we obtained for the papers and aluminum and the majority of the other outdoor sources that were measured did show a high albedo with a low temperature or vice versa. When albedo was plotted against infrared temperature, we would expect an inverse relationship.

*As albedo increases, we would expect infrared temperature to decrease and vice versa. We would expect this because surfaces that have higher albedos are reflecting more and therefore absorbing less, and thus they would have less energy to emit as infrared radiation.*

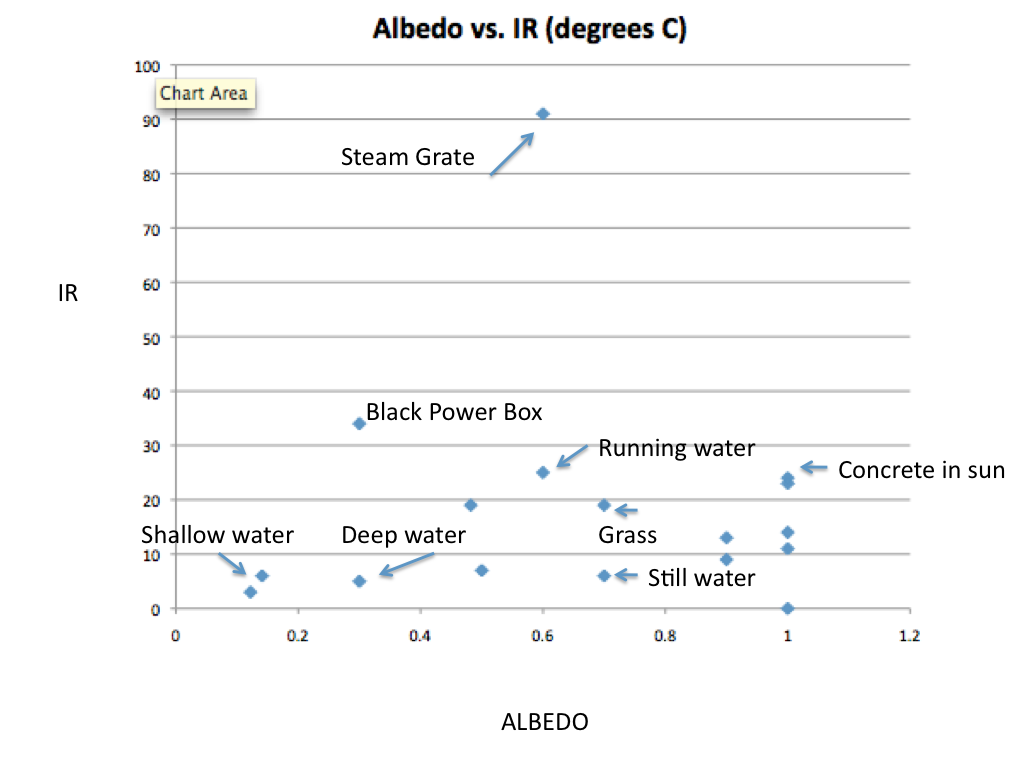
Conversely, we would expect albedo to decrease as infrared temperature increases because surfaces that have higher infrared temperatures have absorbed more energy—and thus reflected less.

Discussion:

The inferences we draw from this lab can be used in selection of materials as well as in the study of the warming of Earth’s atmosphere.

**Table 1. CLASSROOM MEASUREMENTS**

|  |  |  |  |
| --- | --- | --- | --- |
| Color of Paper | Visible Light Reflected (lux) | Albedo | Emitted IR Radiation (°(C) |
| Aluminum | 101.9 | 1.000 | 24 |
| Black | 5.6 | 0.0550 | 23 |
| White | 74.5 | 0.731 | 23 |
| Pink | 63.4 | 0.622 | 24 |



**LOCATION**

N 36° 01.150' W 078° 55.257'

**Table 2 .CAMPUS MEASUREMENTS**

|  |  |  |  |
| --- | --- | --- | --- |
| SURFACE | VISIBLE LIGHT REFLECTED (lux) | ALBEDO | EMITTED IR RADIATION (°C) |
| white paper | 8457 \*topped out | 1 | 11°C |
| black paper | 4955 | 0.586 | 25°C |
| pink paper | 8457 \*topped out | 1 | 14°C |
| aluminum | 8457 \*topped out | 1 | 0°C |
| grass | 5476 | 0.648 | 19°C |
| steam grate | 4635 | 0.548 | 91°C |
| reeds | 7570 | 0.895 | 13°C |
| bricks | 7568 | 0.895 | 9°C |
| concrete (sun) | 8457 \*topped out | 1 | 24°C |
| concrete (shade) | 1028 | 0.122 | 3°C |
| water (still) | 5956 | 0.704 | 6°C |
| water (running) | 3896 | 0.461 | 7°C |
| water (shallow) | 1189 | 0.141 | 6°C |
| water (deep) | 2834 | 0.335 | 5°C |
| tree | 4074 | 0.482 | 19°C |
| rocks (sun) | 8457 \*topped out | 1 | 9°C |
| rocks (shade) | 1066 | 0.126 | 7°C |
| pavement | 3586 | 0.424 | 23°C |
| black power box | 2637 | 0.312 | 34°C |
| white power box | 8457 \*topped out | 1 | 23°C |

Steam Grate